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FORM PTO-1390 (Modified) (REV 10-95) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER **990.1202**	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 09/403912	
INTERNATIONAL APPLICATION NO. **PCT/FI98/00355**	INTERNATIONAL FILING DATE **22 April 1998 (22.04.1998)**	PRIORITY DATE CLAIMED **30 April 1997 (30.04.1997)**

TITLE OF INVENTION

METHOD AND EQUIPMENT FOR ATTENUATION OF OSCILLATION IN A PAPER MACHINE OR IN A PAPER FINISHING DEVICE

APPLICANT(S) FOR DO/EO/US

Jouko KARHUNEN; Arto PURANEN; Jorma KOLIO; Esa LEHTOVIRTA; and Erkki HIETAMAKI

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☒ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 18 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
    A **SECOND** or **SUBSEQUENT** preliminary amendment.
16. ☐ A substitute specification.
17. ☐ A change of power of attorney and/or address letter.
18. ☒ Certificate of Mailing by Express Mail
19. ☒ Other items or information:

- Letter Re Priority

PCTUS1/REV03

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U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/403912	PCT/FI98/00355	990.1202

20. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS	PTO USE ONLY
☒ Search Report has been prepared by the EPO or JPO	$840.00		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482)	$670.00		
☐ No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))	$760.00		
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO	$970.00		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)	$96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =		**$840.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)).	☐ 20 ☐ 30	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	26 - 20 =	6	x $18.00	**$108.00**	
Independent claims	2 - 3 =	0	x $78.00	**$0.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$948.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).**			☐	**$0.00**	
SUBTOTAL =				**$948.00**	
Processing fee of **$130.00** for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492 (f)).			☐ 20 ☐ 30 +	**$0.00**	
TOTAL NATIONAL FEE =				**$948.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☒	**$40.00**	
TOTAL FEES ENCLOSED =				**$988.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$988.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees. A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **50-0518** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

STEINBERG & RASKIN, P.C.
1140 Avenue of the Americas
New York, New York 10036

SIGNATURE

Martin G. Raskin
NAME

25,642
REGISTRATION NUMBER

October 28, 1999
DATE

09/403912

420 Rec'd PCT/PTO 28 OCT 1999

990.1202

UNITED STATES PATENT AND TRADEMARK OFFICE

Re: Application of: Jouko KARHUNEN et al.

Serial No.: Not yet known

Filed: Simultaneously

For: METHOD AND EQUIPMENT FOR ATTENUATION OF OSCILLATION IN A PAPER MACHINE OR IN A PAPER FINISHING DEVICE

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

October 28, 1999

Sir:

Prior to examination and calculation of the filing fee, please amend the above-identified application as follows.

IN THE SPECIFICATION:

Please amend the specification as follows (reference is made to the lines as numbered).

Page 1, line 6, insert --**FIELD OF THE INVENTION**--; and

line 10, insert --**BACKGROUND OF THE INVENTION**--.

Page 2, line 10 insert --**OBJECTS AND SUMMARY OF THE INVENTION**--.

Page 4, line 19, insert --**BRIEF DESCRIPTION OF THE DRAWINGS**--;

line 29, change "fully schematic illustration of" to --a graph showing--.

Page 5, line 4, delete “embodiment”;

line 4, after “apparatus” insert --in accordance with the present invention--;

line 12, delete “finally”;

line 14, insert --**DETAILED DESCRIPTION OF THE INVENTION**--.

Page 10, line 31, change “they” to --there--;

line 32, insert after “metals” insert --which are suitable--.

IN THE ABSTRACT:

Please insert the Abstract submitted on a separate sheet herewith.

IN THE CLAIMS:

Please amend the claims as follows.

Claim 1, line 3, after “comprises” insert --suspending--;

line 3, delete “suspended”;

line 4, delete “whereby in the method,”;

line 4, before “the spring constant”, insert --changing--;

line 5, delete “is/are changed”;

line 7, change “characterized in that” to --whereby--.

Claim 2, line 1, change “characterized in that” to --wherein--.

Claim 3, line 1, change “claim 1 or 2” to --claim 1--;

line 2, change “characterized in that” to --wherein--;

Claim 4, line 1, change “characterized in that” to --wherein--.

Claim 5, line 1, change "characterized in that" to --wherein--.

Claim 6, line 1, change "claim 1 or 2" to --claim 1--;

line 1, change "characterized in that" to --wherein--.

Claim 7, line 1, change "characterized in that" to --wherein--.

Claim 8, line 1, change "characterized in that" to --wherein--.

Claim 9, line 7, change "characterized in that" to --wherein--.

Claim 10, line 1, change "characterized in that" to --wherein--.

Claim 11, line 1, change "claim 9 or 10" to --claim 9--;

line 1, change "characterized in that" to --wherein--.

Claim 12, line 1, change "characterized in that" to --wherein--.

Claim 13, line 1, change "claim 11 or 12" to --claim 11--;

line 1, change "characterized in that" to --wherein--.

Claim 14, line 1, change "characterized in that" to --wherein--.

Claim 15, line 1, change "any one of claims 12 to 14" to --claim 12--;

line 1, change "characterized in that" to --wherein--.

Claim 16, line 1, change "characterized in that" to --wherein--.

Claim 17, line 1, change "any one of claims 12 to 16" to --claim 12--;

line 1, change "characterized in that" to --wherein--.

Claim 18, line 1, change "any one of claims 9 to 17" to --claim 9--;

line 1, change "characterized in that" to --wherein--.

Claim 19, line 1, change "characterized in that" to --wherein--.

Claim 20, line 1, change "any one of claims 9 to 19" to --claim 9--;

line 1, change "characterized in that" to --wherein--.

Claim 21, line 1, change "any one of claims 9 to 20" to --claim 9--;

line 1, change "characterized in that" to --wherein--.

Claim 22, line 1, change "any one of claims 9 to 21" to --claim 9--;

line 1, change "characterized in that" to --wherein--.

Claim 23, line 1, change "any one of claims 9, 10, 21 or 22" to --claim 9--;

lines 1-2, change "characterized in that" to --wherein--.

Claim 24, line 1, change "characterized in that" to --wherein--.

Claim 25, line 1, change "characterized in that" to --wherein--.

Claim 26, line 1, change "any one of claims 23 to 25" to --claim 23--;

line 1, change "characterized in that" to --wherein--.

REMARKS

Claims 1-26, submitted to the International Bureau on September 29, 1998 which replaced original claims 1-30, have been amended to remove multiple dependencies and correct minor informalities. Please utilize claims 1-26 as amended above, as opposed to original claims 1-30, for purposes of this application.

The specification has been amended to include section headings at appropriate locations.

An Abstract is also submitted herewith.

Respectfully submitted,

STEINBERG & RASKIN, P.C.

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Encl.
Abstract

ABSTRACT

A method and apparatus for damping vibration in a paper machine. The apparatus having a dynamic damper which includes a weight suspended by a spring. The spring constant of the spring is changed by means of a control device in order to tune the natural frequency of the dynamic damper. The dynamic damper is tuned to a frequency that is substantially equal to a multiple of the rotational frequency of the roll in the paper machine that is being damped.

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Method and equipment for attenuation of oscillation in a paper machine or in a paper finishing device

The invention relates to a method and an apparatus for damping vibration in a paper machine or in a paper finishing device by means of a dynamic damper which comprises an additional weight suspended from a vibrating system by means of a spring.

In paper machines and in paper finishing devices, vibrations constitute a major problem and, in present-day systems, when attempts are being made to achieve ever higher speeds, the vibration problems have become still more apparent than before. There are several possible sources of vibration in paper machines, and some of the most significant of them are rolls and cylinders, which comprise a very great mass revolving at a considerable speed. It is clear, of course, that when rolls are manufactured, attempts are being made to make their measurement precision as good as possible and, in addition, they are balanced in order to eliminate the vibrations.

However, present-day paper machines and paper finishing devices increasingly employ rolls provided with a soft coating, which rolls in operation may form a very significant source of vibration. Such rolls are used, for example, in on-line and off-line calenders, coating machines, size presses, supercalenders and equivalent, where said roll provided with a soft coating forms a nip with another roll. A paper web and possibly a felt, wire or equivalent is passed through the nip. When in this kind of nip roll arrangement, the seam of the wire, felt or web, considerable impurities or something else causing a noticeable change in the thickness of the web travelling through the nip, passes/pass through the nip during running, the coating must yield elastically, with the result that the coating serves as a spring that excites vibration. For example, in a size press and in a coating device of the size press type, the nip is defined by means of two rolls such that one nip roll is mounted by means of bearing housings directly on the frame structure of said device, while the opposite

roll is mounted at its bearing housings on loading arms that are attached by means of articulated joints to the frame structure of the machine. In that case, the roll mounted on the loading arms in particular begins to vibrate, in which connection the coating of the soft-faced roll is deformed, with the result that the vibration increases and the roll begins to resonate. Until now, it has been necessary to take care of and to eliminate such vibrations so that, by changing the running speed of the machine, such a running speed has been sought that, at said running speed, the vibration does not grow any stronger but begins to be attenuated. The vibration problems have prevented the use of certain speeds.

An object of the present invention is to provide a novel method and apparatus for damping vibrations that are being created such that the vibration can be damped by means of said method and apparatus without changing the running speed. The invention is based on the use of a dynamic damper, and the method in accordance with the invention is mainly characterized in that, in the method, the spring constant of a spring of the dynamic damper and/or the mass of the dynamic damper is/are changed by means of a control device in order to tune the natural frequency of the dynamic damper.

The apparatus in accordance with the invention is, in turn, characterized in that the apparatus comprises a control device which is arranged to change the spring constant of a spring of a dynamic damper and/or the mass of the dynamic damper in order to tune the natural frequency of the dynamic damper.

In an advantageous application of the invention, the vibration induced by rolls that are in nip contact is damped by means of the dynamic damper such that the damper is tuned to a frequency that is substantially equal to a multiple of the rotational frequency of the roll that is closest to the natural frequency of the vibrating system. The dynamic damper can also be tuned substantially directly to a frequency that corresponds to the problematic excitation frequency of a vibrating system.

In one advantageous embodiment of the invention, in the method, the vibration frequencies of a vibrating system are measured constantly by means of one or more vibration detectors, the measurement signals given by the vibration detector are amplified by means of an amplifier and fed into a vibration analyser which identifies the problematic excitation frequency and converts said problematic excitation frequency into a control signal which is fed into a control device in order to tune the dynamic damper.

In one application of the invention, the spring of the dynamic damper is a rod fixed at one end thereof to a vibrating system, such as, for example, a bearing housing of a roll, in a substantially horizontal direction, on support of which rod an additional weight is mounted. In that case, the control device may be arranged to change the spring constant of the spring of the dynamic damper by changing the position of the additional weight on said rod.

Preferably, a locking means is fitted on the rod serving as the spring of the damper in order to lock the additional weight in place after the tuning frequency of the damper has been made as desired. The rod and the additional weight disposed on the rod may be provided with threads fitting each other so that the position of the additional weight on the rod may be adjusted by rotating said additional weight on the rod. In this kind of arrangement, the locking means is arranged to act in the axial direction of the rod and to produce an axial force acting on the additional weight in order to provide a frictional force necessary for locking between the matching threads on the rod and on the additional weight.

The locking means is preferably a pneumatically operated piston device which is fixed on the rod and which is telescopic in order to provide the necessary stroke length.

In one embodiment of the invention, the additional weight included in the dynamic damper comprises a container suspended from the spring and filled with a liquid, the amount of the liquid in said container being adjustable in order to regulate the mass.

In that connection, the control device is connected, for example, to a pump and a valve in order to regulate the amount of the liquid.

In one embodiment of the invention, the rod serving as the spring of the dynamic damper is made of memory metal. In this case, the natural frequency of the damper is arranged to be tuned by regulating the temperature of the rod made of a memory metal material by means of electric resistors or equivalent heaters. In this kind of embodiment of the invention, the additional weight can be attached to the rod rigidly and without a clearance, thereby providing a simpler construction in this respect.

The invention provides a significant advantage over prior art especially in that vibration is damped by means of the method and the apparatus in accordance with the invention without changing the running speed of the machine. A substantial and significant advantage is also that the apparatus is very simple in its construction and in its mode of implementation and that it can be connected by very simple operations to existing structures for the purpose of damping vibrations. The further advantages and characteristic features of the invention will become apparent from the following detailed description of the invention.

In the following, the invention will be described by way of example with reference to the figures in the accompanying drawing.

Figure 1 schematically depicts a size press or a coating machine of the size press type to which the apparatus in accordance with the invention can be applied.

Figure 2 shows in schematic form one example of the apparatus in accordance with the invention.

Figure 3 is a fully schematic illustration of an advantageous mode of tuning a damper.

Figure 4 is an illustration corresponding to that of Fig. 2 of another example of the apparatus in accordance with the invention.

Figure 5 shows a further embodiment example of the apparatus.

Figure 6 shows an embodiment of the invention in which a special locking means is used for an additional weight of a damper.

Figures 7A and 7B are more detailed sectional views of the locking means shown in Fig. 6.

Figure 8 is finally a schematic view of a damper in which a memory metal material is used in the spring of the damper.

Fig. 1 has been included merely to illustrate one possible application of the invention and, thus, Fig. 1 shows a size press or equivalent, which is generally denoted with the reference numeral 10. The size press 10 comprises a frame 14 on which a first size press roll 11 has been mounted directly by means of bearing housings 12. In the illustration of Fig. 1, said roll 11 is provided with a soft roll coating 13. Loading arms 16 have been mounted pivotally on the frame 14 of the size press by means of a pivot shaft 15 extending in the cross direction of the machine, on support of which loading arms a second roll 1 defining a nip N with the first roll 11 has been mounted at its bearing housings 2. For the purpose of providing a desired linear load in the nip N, the loading arms 16 are loaded by means of hydraulic cylinders 17, by whose means the nip N may also be opened. The reference signs 18 and 19 designate coating units by whose means a coating material, such as size, pigment coating material or equivalent is applied to the surface of the rolls. In a normal way, a web W is passed through the nip N.

When a seam or some other equivalent thicker part travels through the nip N in the size press shown in Fig. 1, the coating 13 is deformed and it functions as a spring, with the result that the apparatus, in particular the roll 1 pivotally mounted on the

frame 14, begins to vibrate. Vibration deforms the roll coating 13 further, whereupon the vibration is intensified and the roll 1 is brought to a resonating state. In conventional arrangements, this has led to the fact that it has been necessary to change the running speed because it has not been possible to dampen the vibration otherwise. In the invention, however, the damping of vibration has been taken care of such that a dynamic damper that is automatically tuned in accordance with the invention is mounted on the bearing housing 2 of the vibrating roll 1, which damper is illustrated in more detail in Fig. 2 of the drawing.

As shown in Fig. 2, the apparatus in accordance with the invention is in its principle very simple. In principle, the invention is constituted by a dynamic damper known per se and fitted on a vibrating system, i.e. in this case on the bearing housing 2 of the roll 1, which damper comprises a mass 4 suspended from the vibrating system 2 by means of a spring 3. In the illustration of Fig. 2, the spring is a rod 3 rigidly fitted on the bearing housing 2 by means of attachment members 5, which rod is additionally provided with threads in the example of the figure. As the mass serves a weight 4 which is fitted on the rod 3 and which can be displaced by means of the threads in the longitudinal direction of the rod 3 such that the distance a of the weight 4 from the bearing housing 2 can be regulated. As already stated once above, the damper is thus a dynamic damper known per se. The basic equation of dimensioning the dynamic damper is simply:

$k/m = \Omega^2$ where k = the spring constant of the spring, i.e. the rod 3 in this case, m = the mass of the weight 4, and Ω = the angular velocity of the vibrating system, i.e. the bearing housing 2.

The effect of the dynamic damper is based in one advantageous embodiment of the invention on the fact that the natural frequency of said damper is tuned so as to be equal to the problematic excitation frequency. In this connection, it shall be pointed out that there may be several problematic excitation frequencies that differ from one another, but in one example which employs a coating machine of the size press type like the one shown in Fig. 1 there was a so-called lower problem frequency, in which the motion of bearing housings was large, of the order of about 50 Hz. Since

the effective damping capacity of the dynamic damper is, however, limited to a relatively narrow frequency band, it is clear that it must be possible to regulate the natural frequency of the damper. As it is commonly known that, for example, in the case shown in Fig. 2, the spring constant k of the rod 3 is inversely proportional to the power of three of the length of the rod, it is easy to regulate the natural frequency of the damper by adjusting the distance a of the weight 4 from the bearing housing 2. When the natural frequency of the damper has been made equal to the problematic excitation frequency by changing the distance a, the bearing housing 2 ceases to vibrate and the weight 4 resting on support of the rod 3 begins to vibrate, respectively. This means that the arrangement formed by means of an additional spring, i.e. the rod 3, and an additional weight, i.e. the weight 4, produces a force that is in an opposite phase and of equal magnitude to the excitation, whereby the vibration of the machine itself ceases.

As already stated above, a vibrating system or an equivalent object may have several problematic excitation frequencies because, depending on the system, it may include several devices which vibrate at different frequencies. For example, in the size press arrangement described previously, a significant source of vibration in the system is a vibrating roll. In this kind of example, the natural frequency of the vibrating system is not necessarily equal to a multiple of the rotational frequency of the roll inducing the vibration (in most instances this is not the case). In that connection, a very effective way of damping the vibrations of the system is that the damper, for example, a damper of the kind illustrated in Fig. 2, is tuned to a frequency which corresponds to a multiple of the rotational frequency of the roll that is closest to the natural frequency of the vibrating system. This multiple of the rotational frequency is thus used as the tuning frequency of the damper. This is illustrated fully schematically in Fig. 3, which shows the relation between the natural frequency of a vibrating system and multiples of the rotational frequency of a roll in a frequency/amplitude coordinate system.

If the device in question were a device that is operated continuously at a constant speed, the vibrations could be brought under control merely by tuning the natural

frequency of the dynamic damper once to a correct level. However, in the paper machine application, the running speeds and thus the vibration frequencies too vary. Consequently, it must be possible to regulate the dynamic damper fairly precisely. In the inventive arrangement shown in Fig. 2, adjustability is provided such that the bearing housing 2 whose vibration is desired to be damped is provided with a vibration detector 6. The vibration detector 6 transmits a signal that is amplified by an amplifier 7 and passed further to a computer 8 serving as a vibration analyser, which filters and analyses the vibration frequencies and locates the problematic excitation frequency among the frequencies and converts it into a control signal and transmits said control signal to a control device 9 which moves the weight 4 on the rod 3. The control device 9 is advantageously, for example, a stepping motor. The apparatus thus comprises a closed control circuit that constantly measures and analyses vibrations and, based on this, regulates the natural frequency of the dynamic damper.

The illustration of Fig. 4 corresponds to that of Fig. 2 so that this example also uses a vibration detector 6 that measures and identifies the vibrations of a bearing housing 2 and transmits in accordance therewith a signal that is amplified by an amplifier 7 and passed further to a vibration analyser 8. The vibration analyser 8 converts the problematic excitation frequency it has found from the vibration frequencies analysed by it into a control signal and transmits it to a control device 9. The dynamic damper differs in this example from the one described previously such that the damper comprises a spring 3a which is suspended from the bearing housing 2 and from which a weight 4a is suspended whose mass can be changed. The spring 3a itself is here constant in length. The weight 4a comprises, for example, as shown in Fig. 3, a container and a liquid in said container, the amount of said liquid being regulated by means of a pump 21 and a valve 22. The container is denoted with the reference sign 23. The control device 9 thus controls said pump 21 and valve 22 based on the control signal received by it in order to change the amount of the liquid in the container of the weight 4a.

Fig. 5 shows a further embodiment of the invention which differs from the ones described previously. In this embodiment, the spring 3b of the dynamic damper comprises a rod that is mounted and attached to a bearing housing 2 in a way corresponding to the illustration of Fig. 2. The weight 4b of the damper in turn corresponds in structure and in operation to the illustration of Fig. 3 so that it comprises a container and a liquid therein whose amount is regulated by means of a pump 21 and a valve 22. In the illustration of Fig. 5, the weight 4b is, however, suspended from the spring 3b such that its distance a from the bearing housing 2 can be changed, for example, in a way corresponding to that shown in Fig. 2. Accordingly, both the distance a of the weight 4b from the bearing housing 2 and the mass of the weight 4b are regulated in the illustration of Fig. 5.

Fig. 6 shows an embodiment of the apparatus in accordance with the invention which is provided with a locking means 30 by whose means an additional weight 4 can be locked in place on the rod 3. In accordance with the embodiments described above, the rod 3 serving as the spring of the dynamic damper is attached to a vibrating system 2, such as, for example, a bearing housing by means of suitable attachment members 5. Fig. 6 further shows that the rod 3 is provided with threads 3' and, in a similar way, the additional weight is provided with threads matching said threads 3' so that said additional weight may be moved on the rod 3 by rotating, i.e. by "screwing". Once the additional weight 4 has been brought to a correct place on the rod 3, it is locked in place by means of the locking means 30, which produces a force in the axial direction of the rod 3 in order to provide a frictional force necessary for locking between the rod 3 and the additional weight 4. As shown in Fig. 6, the locking means 30 is preferably attached to a free outer end of the rod 3. In Fig. 6, the locking means 30 is shown in a free position, in which connection the additional weight 4 can be moved by rotating on the rod 3. The structure and operation of the locking means 30 is illustrated in more detail in schematic sectional views 7A and 7B.

Figs. 7A and 7B thus show the structure of the locking means 30 in more detail. Fig. 7A shows the locking means 30 in a free position corresponding to that of Fig.

6 and, correspondingly, in Fig. 7B, the locking means 30 is shown in a locking position. The locking means 30 comprises a cylindrical casing 31 which confines within it a cavity that serves as a pressure space 32. A piston 33 is disposed in this pressure space 32 and sealed by means of seals against the inner wall of the casing 31, said piston 33 being telescopic in the illustrated embodiment comprising telescopic parts 34. The piston 33 is attached to the rod 3, preferably in the fashion shown in Figs. 7A and 7B to the outer end of the rod 3 immovably, and the cylindrical casing 31 of the locking means 30 is thus fitted axially movably on the piston 33 and on the rod 3. The piston 33 divides the pressure space 32 in the axial direction in two parts, which are both provided with a connecting member 36, 37 for feeding in a pressure medium. Compressed air is preferably used as the pressure medium. Depending on the side of the piston 33 into which the pressure medium is passed, the locking means is brought either to the free position shown in Fig. 7A or to the locking position shown in Fig. 7B. In the locking position, the casing 31 of the locking means 30 has been displaced so that the end face 35 of the casing facing the additional weight 4 lies against said additional weight. The additional weight 4 is shown in Figs. 7A and 7B only partially and schematically. When the pressure medium is conducted through the connecting member 37 into the pressure space of the locking means 30, an axial force needed for locking is produced, which force provides a frictional force of required magnitude between the thread 3' on the rod 3 and the matching thread on the additional weight 4.

Finally, Fig. 8 shows fully schematically an alternative of the invention where the spring of the dynamic damper, i.e. the rod 3, is made of memory metal. The coefficient of elasticity of memory metal is highly dependent on temperature. In that case, the natural frequency of the damper can be tuned to a right level by regulating the temperature of the rod 3. Regulation of temperature can be performed, for example, by means of electric resistors or equivalent heaters. In this kind of arrangement, an additional weight 4 can be attached to the rod 3 totally rigidly and without a clearance, for example, by welding. The structure may thus be made fairly simple. Regarding memory metals, it may be stated that they are alloys of different metals, of which an alloy of nickel and titanium may be mentioned as one example.

The properties of such an alloy may be regulated by introducing into it a sufficient amount of energy in the form of heating, with the result that the crystal structure of the metal alloy can be changed by this introduction of additional energy. Memory metal "remembers" the change which a certain heating operation brings about in the metal alloy.

It is also conceivable that the dynamic damper is applied in connection with hollow tubular rolls, for example, such that the dynamic damper is disposed inside a roll tube. In this case, the dynamic damper might comprise two or more springs which are fixed to the inner surface of the roll tube while the weight of the dynamic damper is fixed on support of said springs. However, it may be considered that it is more difficult to provide adjustability for this kind of damper than in the examples described previously.

The invention has been described above in connection with a size press and a coating machine of the size press type in particular. However, problems of the similar type are also encountered, inter alia, in soft calenders and in supercalenders, and the apparatus in accordance with the invention may also be applied to them. The problematic excitation frequencies differ, however, in these applications both from one another and from the arrangement shown in Fig. 1.

Above, the invention has been described by way of example with reference to the figures in the accompanying drawing. The invention is, however, not confined to relating only to the examples illustrated in the figures, but different embodiments of the invention may vary within the scope of the inventive idea defined in the accompanying claims.

AMENDED CLAIMS

[received by the International Bureau on 29 September 1998 (29.09.98); original claims 1-30 replaced by new claims 1-26 (5 pages)]

1. A method for damping vibration induced by rolls forming a nip in a paper machine or in a paper finishing device by means of a dynamic damper which comprises an additional weight suspended from a vibrating system by means of a spring, whereby in the method, the spring constant of the spring (3,3b) of the dynamic damper and/or the mass (4a, 4b) of the dynamic damper is/are changed by means of a control device (9) in order to tune the natural frequency of the dynamic damper, **characterized** in that the vibration induced by rolls (1, 11) which are in nip contact is damped by means of the dynamic damper so that the damper is tuned to a frequency that is substantially equal to a multiple of the rotational frequency of the roll that is closest to the natural frequency of the vibrating system, or to a frequency that substantially corresponds to the problematic excitation frequency of the vibrating system.

2. A method as claimed in claim 1, **characterized** in that, in the method, the vibration frequencies of the vibrating system (2) are measured constantly by means of one or more vibration detectors (6), the measurement signals given by the vibration detector (6) are amplified by means of an amplifier (7) and fed into a vibration analyser (8), which identifies the problematic excitation frequency and converts said problematic excitation frequency into a control signal, which is fed into a control device (9) in order to tune the dynamic damper.

3. A method as claimed in claim 1 or 2 wherein the spring of the dynamic damper is a rod (3) attached at one end thereof to the vibrating object, **characterized** in that the spring constant is changed by changing the position of the additional weight (4) on the rod (3).

4. A method as claimed in claim 3, **characterized** in that when the tuning frequency of the dynamic damper has been made as desired, the additional weight (4) is locked in place on the rod (3) by means of a locking means (30).

5. A method as claimed in claim 4, **characterized** in that the locking means (30) is operated by means of compressed air.

6. A method as claimed in claim 1 or 2, **characterized** in that a rod (3) made of memory metal is used as the spring of the dynamic damper.

7. A method as claimed in claim 6, **characterized** in that the natural frequency of the damper is tuned to a correct level by regulating the temperature of the rod made of a memory metal material.

8. A method as claimed in claim 7, **characterized** in that the temperature of the rod is regulated by means of electric resistors or equivalent heaters.

9. An apparatus for damping vibration induced by rolls forming a nip in a paper machine or in a paper finishing device by means of a dynamic damper which comprises an additional weight (4, 4a, 4b) suspended from a vibrating system (2) by means of a spring (3,3a,3b), said apparatus further comprising a control device (9) which is arranged to change the spring constant of the spring (3, 3b) of the dynamic damper and/or the mass (4a, 4b) of the dynamic damper in order to tune the natural frequency of the dynamic damper, **characterized** in that the apparatus is fitted to dampen the vibration induced by rolls (1,11) forming a nip such that the control device (9) is arranged to tune the damper to a frequency that is substantially equal to a multiple of the rotational frequency of the roll that is closest to the natural frequency of the vibrating system, or to a frequency that substantially corresponds to the problematic excitation frequency of the vibrating system.

10. An apparatus as claimed in claim 9, **characterized** in that the apparatus comprises one or more vibration detectors (6) which measure(s) the vibration frequencies of the vibrating system (2) constantly and which is/are arranged to transmit a measurement signal, an amplifier (7) that amplifies the measurement signal, a vibration analyser (8) which is arranged to receive the measurement signal transmitted by the vibration detector (6) and amplified by the amplifier (7), to

identify the problematic excitation frequency from said signal and to convert said problematic excitation frequency into a control signal to be fed into the control device (9) in order to tune the dynamic damper.

11. An apparatus as claimed in claim 9 or 10, **characterized** in that the spring (3, 3b) of the dynamic damper is a rod fixed at one end thereof to the vibrating system (2) in a substantially horizontal direction, on support of which rod the additional weight (4,4b) is mounted, and that the control device (9) is arranged to change the spring constant of the spring (3,3b) of the dynamic damper by changing the position of the additional weight (4,4b) on the rod (3,3b).

12. An apparatus as claimed in claim 11, **characterized** in that a locking means (30) is mounted on the rod (3) serving as the spring of the damper in order to lock the additional weight (4) in place when the tuning frequency of the damper has been made as desired.

13. An apparatus as claimed in claim 11 or 12, **characterized** in that the rod (3) and the additional weight (4) fitted on the rod are provided with matching threads (3'), and that the position of the additional weight (4) on the rod (3) can be regulated by rotating said additional weight on the rod.

14. An apparatus as claimed in claim 13, **characterized** in that the locking means (30) is arranged to act in the axial direction of the rod (3) and to produce an axial force acting on the additional weight (4) in order to provide a frictional force necessary for locking between the matching threads on the rod (3) and on the additional weight (4).

15. An apparatus as claimed in any one of claims 12 to 14, **characterized** in that the locking means (30) is a piston device fixed onto the rod.

16. An apparatus as claimed in claim 15, **characterized** in that the piston device (30) is telescopic in order to provide the necessary stroke length.

17. An apparatus as claimed in any one of claims 12 to 16, **characterized** in that the locking means (30) is operated by compressed air.

18. An apparatus as claimed in any one of claims 9 to 17, **characterized** in that the additional weight (4a,4b) included in the dynamic damper comprises a container suspended from the spring (3a,3b) and filled with a liquid, the amount of the liquid in said container being adjustable in order to regulate the mass.

19. An apparatus as claimed in claim 18, **characterized** in that the control device (9) is connected to a pump (21) and to a valve (22) in order to regulate the amount of the liquid.

20. An apparatus as claimed in any one of claims 9 to 19, **characterized** in that the control device (9) comprises a stepping motor or equivalent in order to change the location of the mass of the dynamic damper.

21. An apparatus as claimed in any one of claims 9 to 20, **characterized** in that the apparatus is fitted so as to dampen vibration in a nip in which at least one of the rolls forming the nip is provided with a soft coating (9).

22. An apparatus as claimed in any one of claims 9 to 21, **characterized** in that the dynamic damper and the vibration detectors (6) are fitted and fixed to the bearing housing (2) of the roll.

23. An apparatus as claimed in any one of claims 9, 10, 21 or 22, **characterized** in that the spring of the dynamic damper is a rod (3) made of memory metal.

24. An apparatus as claimed in claim 23, **characterized** in that the natural frequency of the damper is arranged to be tuned by regulating the temperature of the rod made of a memory metal material.

25. An apparatus as claimed in claim 24, **characterized** in that, in order to regulate the temperature of the rod, the apparatus is provided with electric resistors or equivalent heaters.

26. An apparatus as claimed in any one of claims 23 to 25, **characterized** in that the additional weight (4) is fixed to the rod (3) rigidly and without a clearance.

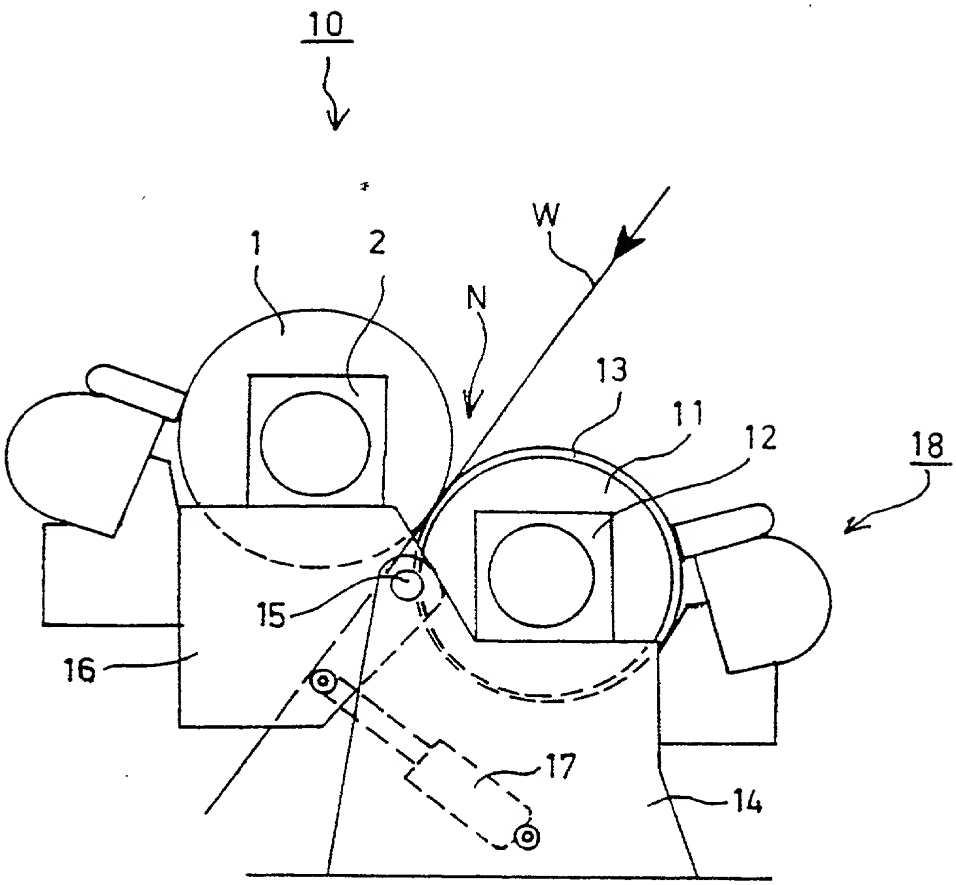

FIG. 1

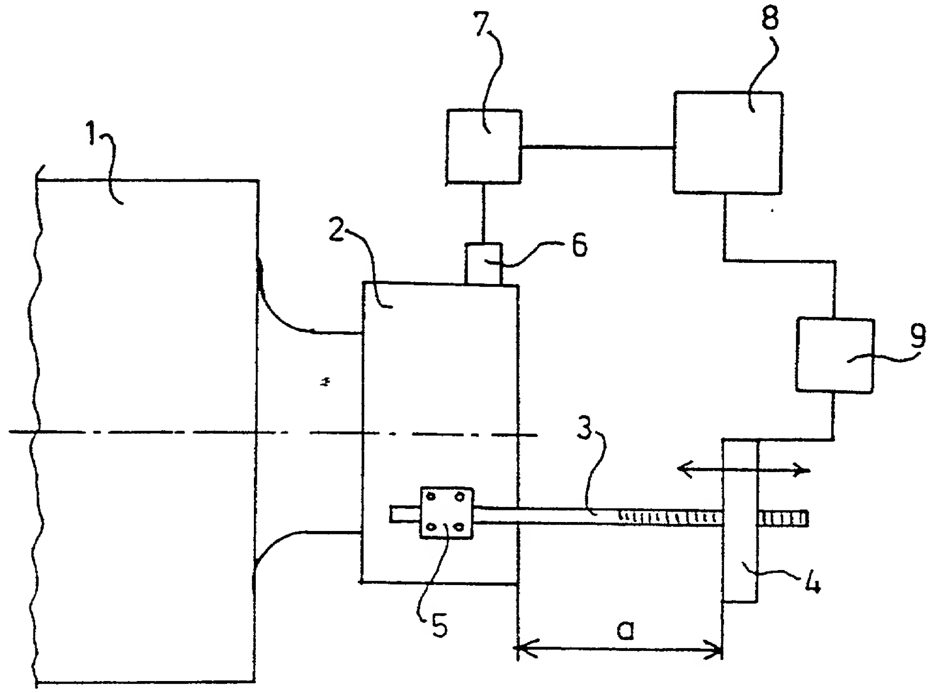
1
2
3
4
5
6
7
8
9
a

FIG. 2

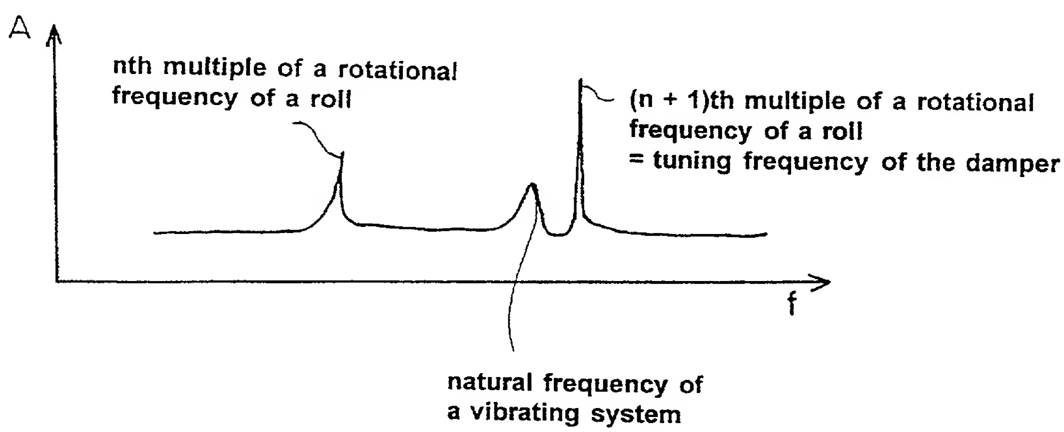
A
nth multiple of a rotational frequency of a roll
(n + 1)th multiple of a rotational frequency of a roll = tuning frequency of the damper
f
natural frequency of a vibrating system

FIG. 3

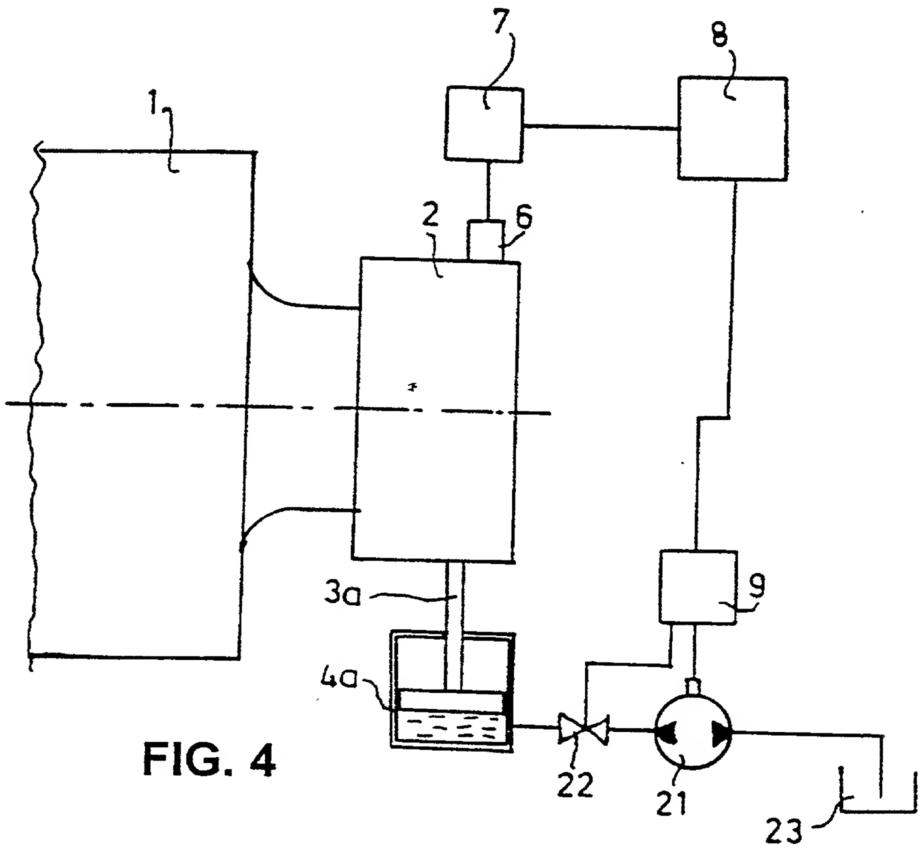

FIG. 4

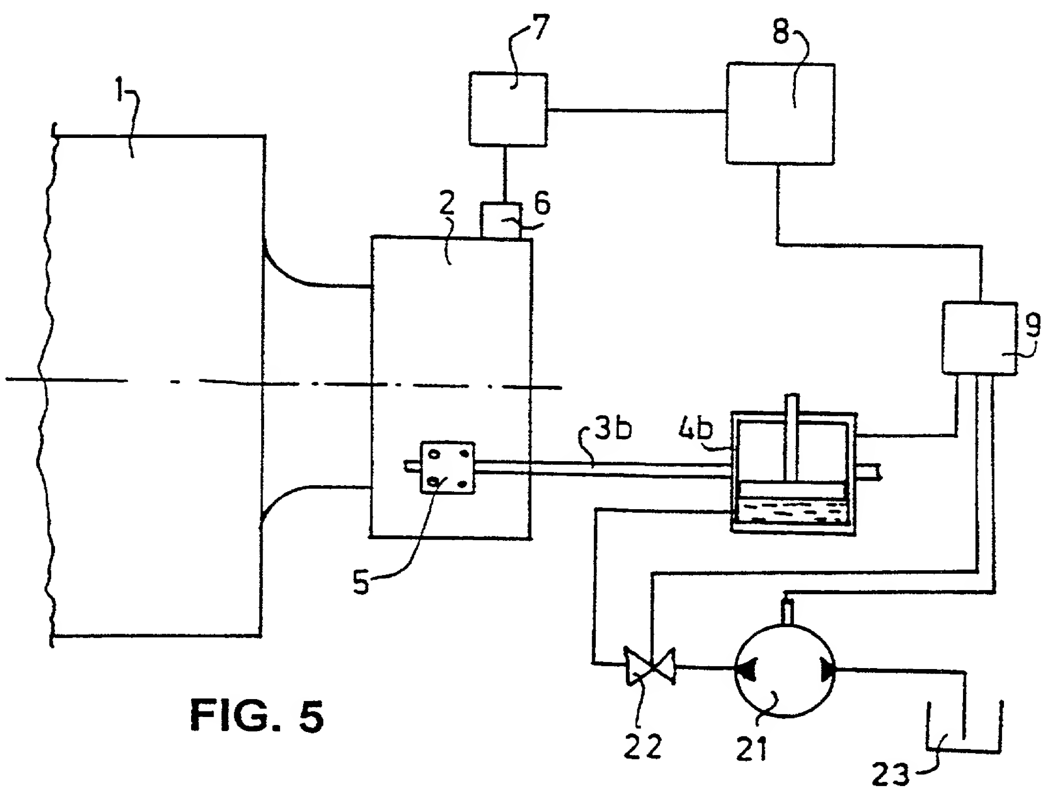

FIG. 5

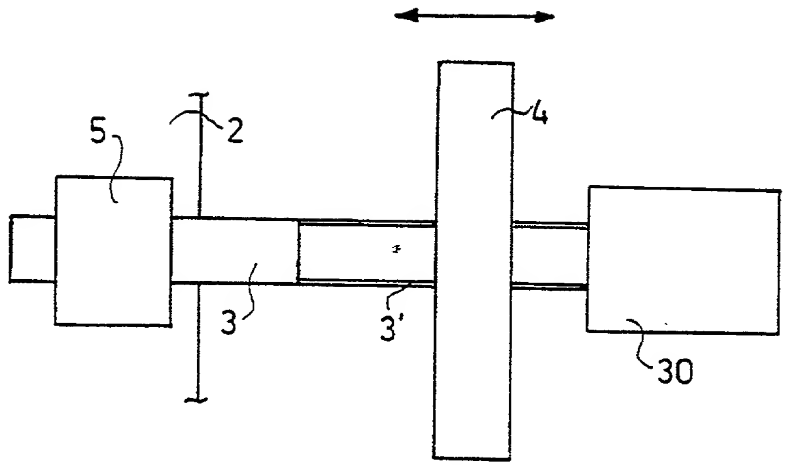

FIG. 6

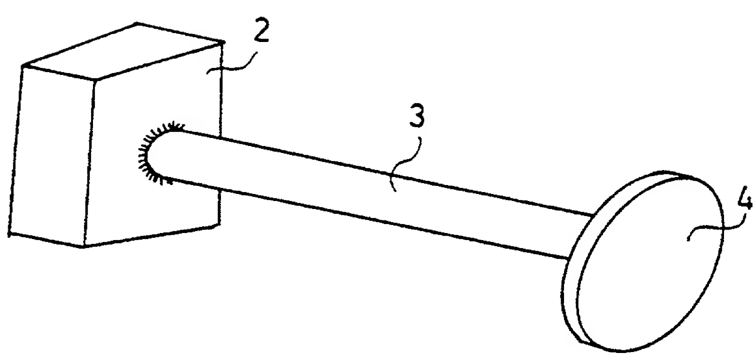

FIG. 8

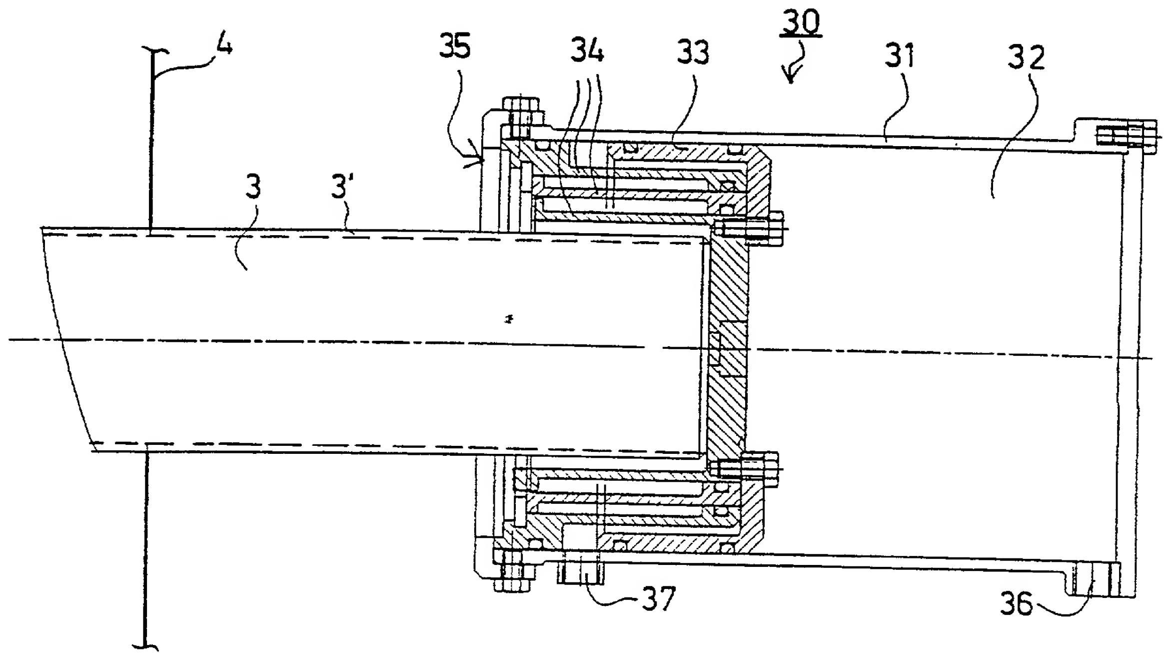

FIG. 7A

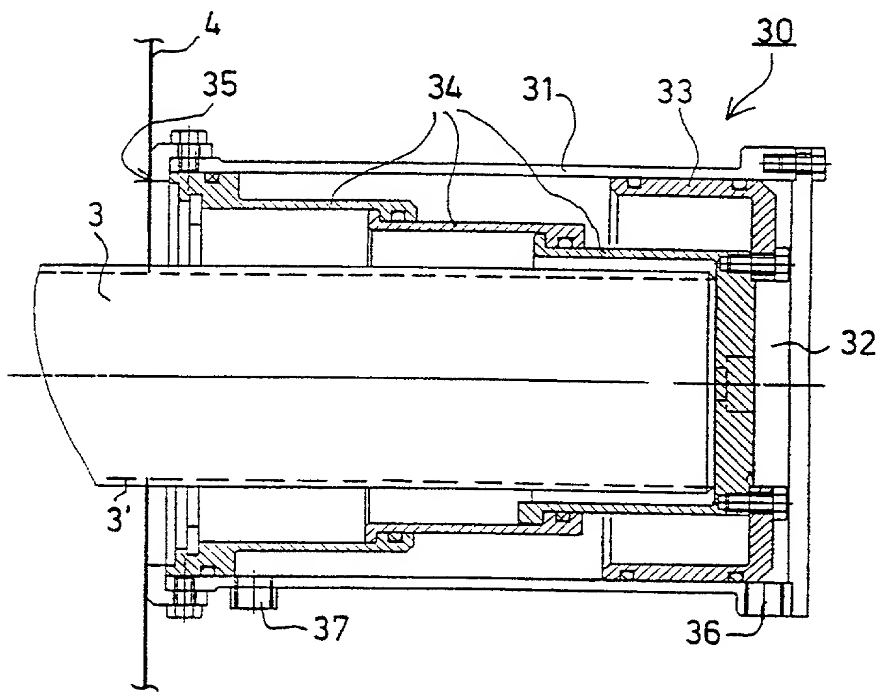

FIG. 7B

Docket No.: 990.1202

U.S.A.
DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: **METHOD AND EQUIPMENT FOR ATTENUATION OF OSCILLATION IN A PAPER MACHINE OR IN A PAPER FINISHING DEVICE**

the specification of which (check one)

__X__ is attached hereto.

_____ was filed on _________ as Application Serial No. ______________ and was amended on _________________. I hereby authorize and request my attorney, Steinberg & Raskin, P.C. of 1140 Avenue of the Americas, New York, New York 10036 to insert the filing date and application number when known.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information which is known to us to be material to the patentability of this application as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code, §119 of any foreign and/or provisional application(s) for patent or inventor's certificate listed below and have also identified below any foreign and/or provisional application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

PRIOR APPLICATIONS			Priority claimed	
971864	**Finland**	**April 30, 1997**	**X**	
			Yes	No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/FI98/00355	**April 22, 1998**	**pending**

And I hereby appoint

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Harold D. Steinberg, Registration No. 17,255,
Brian Roffe, Registration No. 35,336,
Joshua L. Raskin, Registration No. 40,135

(4)

my attorneys, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith; correspondence address:

STEINBERG & RASKIN, P.C.
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

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